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Urbanisation in the United Arab Emirates: The challenges for ecological mitigation in a rapidly developing country

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Abstract

The United Arab Emirates is a small Gulf country with perhaps the fastest rate of infrastructure development anywhere. While there is legislation in place requiring environmental impact assessments (EIA) to be undertaken for all major projects, the speed and scope of development provides special challenges in devising and implementing ecological mitigation against the loss of habitats and biodiversity that this development engenders. This paper critically discusses mitigation strategies that have been attempted, and suggests mitigation strategies in the local context. It is hoped that this will assist both the environmental consultants involved in the EIA process and the competent authorities who issue development licences, to the benefit of the remaining native biodiversity of the area.

Keywords

United Arab Emirates, UAE, mitigation, environmental impact assessment, biodiversity, conservation, translocation

Introduction

The United Arab Emirates (UAE) is a relatively small country (83,600 km^2) with coastline on both the Gulf of Oman and the Arabian Gulf. Politically, the UAE are a

federation of seven individual emirates, each with a considerable degree of autonomy. The land is predominantly arid, much of it is classified as hyperarid (Böer 1997), with a harsh climate of high temperatures, low and irregular precipitation and consequent high evapotranspirative stress. Nonetheless, it is a country of contrastring landscapes, with a wide range of habitats including mountains, sand and gravel deserts, sabkhas (salt flats), and mangrove forests. The diverse fauna and flora exhibit a fascinating range of adaptations to survive in this harsh and forbidding landscape.

Until the discovery and exploitation of oil and gas in the mid-20th century, the human population of the UAE was small and the impact of the human economy on the natural environment was very limited. Since then, the influx of huge wealth, and the economic development that this has allowed, has drastically altered this situation. The human population has risen exponentially from an estimated 86,000 in 1961 (Environment Agency Abu Dhabi), and is expected to top five million during 2009. One consequence of this has been the extremely rapid emplacement of a modern infrastructure, including an extensive highway and road network, residential areas, shopping malls, golf courses, airports and industrial facilities. The scale of such ambitious developments (often referred to as 'mega-projects') has been staggering and superlative on a world scale. Dubai now claims the world's tallest building, largest shopping mall, longest indoor ski slope and largest artificial island. Further projects are planned or already under construction, including the largest airport, artificial canal and seafront developments, although some parts of these developments are currently on hold as a result of the global economic crisis. Abu Dhabi city is also currently expanding at an explosive rate with major developments on the mainland and the adjacent Sadiyat, Reem and Yas Islands.

Conspicuous consumption has also placed the UAE in the unenviable position of having the world's highest ecological footprint at 9.5 global hectares per capita, highest per capita carbon footprint (Global footprint network 2008) and one of the highest per capita water consumption rates. From a plethora of possible examples in different emirates, we briefly describe two projects from Dubai.

The Dubai World Central (DWC) development at Jebel Ali combines the Al Maktoum International Airport with a range of mixed residential, commercial, logistics and recreational facilities. When development is complete the site is planned to house 900,000 people and become the world's largest air passenger and cargo hub. Before development started in 2006, the 140 km^2 site was an area of sand sheets, low dunes and saline plains used principally for low density livestock grazing. The area had a relatively rich desert fauna and flora, including at least nine species of mammals, diverse resident and visiting bird species, 17 reptile species, a wide range of invertebrates, and 43 species of plants (Gardner and Aspinall 2006). While ecological data, life histories and population status are poorly known for numerous species, it is strongly suspected that many species are declining. Species recognized to be of national conservation concern on the site included free-ranging mountain gazelle (*Gazella gazella cora*), cream-coloured courser (*Cursor cursorius*), Pharaoh eagle owl (*Bubo ascalaphus*), the Persian wonder gecko (*Teratoscincus keyserlingii*), Leptien's spiny-tailed lizards (*Uromastyx aegyptia leptieni*) and the ghaf tree (*Prosopis cineraria*).

A second example is the 75 km long Arabian Canal project that is being excavated around Dubai World Central. This canal and landscaping project is being undertaken for real estate purposes, rather than transportation or irrigation. According to the developers (Limitless, Dubai), this project will eventually develop 100 km^2 of land, house up to 2.5 million people, involve moving one billion cubic metres of sand and rock, and build hills up to 200 m tall. The excavation of the canal itself is estimated to cost $ 11 billion, and the development of the "city" will cost a further $ 50 billion. Prior to development starting in 2007, the area was of great interest in terms of its rich biological and habitat diversity. It also had high landscape value which gave a feeling of true wilderness, despite being so close to the major urban and industrial areas of Dubai and Jebel Ali (Gardner and Howarth 2007). As a result of the global economic crisis, it was announced by the developers in late 2008 that the second phase of the development, primarily concerned with inland areas, had been placed on hold, and the proposed schedule for resumption is currently (July 2009) not known.

With infrastructure developments on this scale, the consequent pressures on the natural environment have been drastic, both within the project areas and outside. For example, the enormous demand for aggregate, stone and cement have led to very extensive quarrying in the mountains and gravel extraction on the outwash plains, resulting in loss of pristine mountain habitat and extensive dust pollution. The development of artificial islands, ports, marinas and coastal residential areas has brought alteration and degradation of marine habitats through pollution and dredging.

The UAE, recognizing the need to protect the environment, has emplaced a considerable body of legislation at both federal and individual emirate levels. The federal environmental law of 1999 (No. 24) addresses the protection of the environment and development of its natural resources. As is laid out in Article 2, implementation aims to achieve conservation of natural resources and biological diversity. Furthermore, Article 3 requires developers to identify parts of projects that will cause harm to the environment and identify areas of special environmental importance or sensitivity. Article 4 specifically requires any developer to undertake an environmental impact assessment (EIA) for any development project, including a baseline ecology survey.

Although EIAs are now being undertaken for most categories of development projects in compliance with the law, their remits cover individual project sites with little or no integration into the overall ecology of the landscape or species ranges. It is unfortunately also true that ecology surveys and planning have often been undertaken after construction decisions have been made, and in some cases, after clearing and levelling of the land has started. Moreover, the present limited scientific understanding of habitat ecology and lack of effectively tested mitigation measures, together with limited implementation of suggested mitigation, weakens the EIA process.

The UAE prides itself on the rapid pace of development, in which projects may go from the drawing board to completion in times unheard of elsewhere. Hence in many projects, the contracting companies do not have adequate time to complete the usual requirements of ecological survey for EIA, and nor, in many cases, do master developers or government authorities, insist that they try to do so. Instead, the methodologies

of rapid assessments are used, often with a single snapshot survey undertaken over a few days and without any assessment of seasonality. This may result in a highly distorted view of the ecosystem concerned. For example, in a climate regime where rainfall is unpredictable, the annual and ephemeral flora may only be present for a few weeks, and in drought years, may not appear at all. Surveys conducted in mid-winter may grossly underestimate reptile abundance and diversity, and of course passage migrant birds may only be present for days or weeks. Nonetheless, such transient fauna and flora are key parts of the local ecosystem. Experienced ecologists with local knowledge may be able to factor in such species during a rapid assessment survey, but many assessments are made by visiting ecologists without an adequate background. Indeed many of the ecological baseline surveys being undertaken are woefully inadequate 'walkover surveys' without any consideration of the nocturnal fauna or more cryptic species such as the bats, geckoes, arthropods and other invertebrates, despite these being key parts of local ecological interactions.

The aim of this paper is to discuss possible mitigation options that have been proposed and, in some cases, implemented, in the hope that such suggestions and discussion may assist the EIA planning process in the UAE and other countries.

Mitigation Strategies

Fauna and flora translocation

Destruction and displacement of flora and fauna during development is a major cause of biodiversity loss and habitat fragmentation. One mitigation option that has been proposed and implemented is the translocation of animal and plant species from the development sites to new 'safe' locations. Indeed Dubai Municipality, the competent authority in Dubai Emirate, maintains a list of species they require to be collected and translocated (Dubai Municipality Environment Department no date), and similar exercises have been attempted in Abu Dhabi. Typical species translocated are gazelle (*Gazella* spp.), cape hares (*Lepus capensis*), spiny-tailed lizards and ghaf trees, and in the marine environment, corals. Animal translocations have been hailed in the popular press as 'rescuing' or 'saving' the animals (e.g. Gulf News, 25 June 2005).

Attractive as this option may appear, translocation should generally be viewed as a controversial method of last resort. Translocation is a highly specialised, time consuming and expensive method, which, where possible, should be used in conjunction with other forms of mitigation. For success, operations of this kind require extensive planning and, in many circumstances, need several years or even decades to complete. The success rate may be low, especially as criteria for judging success are not always rigorous and unsuccessful attempts are less likely to be published. Translocations which aimed to solve human-animal conflicts have generally failed (Fischer and Lindenmayer 2000). Without adequate safeguards, translocations may actually result in increased environmental disturbance, and suffering and stress for

the animals concerned. The IUCN/SSC Re-introduction Specialist Group (RSG) has produced stringent guidelines for effective translocation and reintroduction programmes (IUCN/SSC Re-introduction Specialist Group 1998). However these guidelines were never designed for the release of rescued animals from sites under development, but rather for the re-establishment of populations in areas where they have become locally extinct (re-introductions) or depleted (restocking). Nevertheless, the guidelines are useful as a management tool. In summary these require that translocation should only take place where:

- The habitat requirements of the species are satisfied and are likely to be sustained for the foreseeable future.
- The capacity of the area it is proposed to restock should be investigated to assess if the level of the population desired is sustainable.
- The animals or plants being used for restocking must be of the same race as those in the population into which they are released.
- The long term protection of the re-introduction area is assured.
- Actions are based on thorough research into previous re-introductions of the same or similar species.
- Adequate post release monitoring is planned.

Unfortunately, the necessary ecological and monitoring studies have yet to be conducted in the UAE, and translocations have been undertaken in an ad hoc manner. For example, the collection of Leptien's spiny-tailed lizards on sites scheduled for development, and their translocation to another site, where resident animals may already be at carrying capacity, is likely to result in increased competition for burrows, food and space. The likely outcome is stress and mortality for resident and translocated animals alike. Simply providing food and water in the release site, to maintain unnaturally high populations, is not a sustainable strategy, and the consequent effects of this on other species in the ecosystem are unknown. Moreover, if animals are released during the hotter parts of the year from April through to October, and they cannot immediately find shelter in a burrow, they may suffer heat stress and die. In a recent analysis of reptile and amphibian translocations attempted worldwide between 1991 and 2006, the success rate remained low. Of eight translocation attempts motivated by human wildlife conflict (such as development mitigation) only one was considered successful (Germano and Bishop 2009).

Hares have been routinely captured by chasing them down by vehicles. Survival after such trauma has not been monitored. Similarly, corals relocated using inappropriate techniques or placed in sub-optimal environments can have high mortality rates, defeating the purpose of the exercise. Mature ghaf trees grown under natural conditions develop a long tap root to reach the water table. Such roots in translocated trees will be severed, and these trees may therefore be reliant on artificial irrigation for many years. Indeed, it is not certain that trees drip irrigated from the surface can be induced to regrow a tap root.

It is vital that the objectives of any translocations are clear. It is recommended that translocations should only be attempted to re-introduce species into areas from which they have been extirpated through overexploitation or habitat degradation, or to restock to areas where they are similarly depleted. In doing so, the IUCN guidelines should be adhered to rigorously. In order for translocation to be used effectively as a mitigation method, there is an urgent need for detailed ecological and behavioural studies of the organisms concerned together with adequately funded, properly researched and monitored trial translocations. Otherwise such efforts are likely to be futile and divert resources from more effective mitigation strategies. The use of translocation, without full compliance with IUCN guidelines, in a misguided attempt at animal welfare, must be avoided.

Topsoil storage and land restoration

Mitigation of habitat loss may be achieved by land restoration, so that degraded areas can once again sustain habitats of conservation value (Vécrin and Muller 2003). While the difficulties of habitat and community translocation should not be minimised (Bullock 1998), the long-term value of habitat restoration for biodiversity conservation is apparent (Young 2000). A key resource for habitat restoration is the removal, storage and reuse of top soil from areas undergoing development.

The uppermost layer of sandy desert soils includes seeds which only germinate under suitable conditions. In desert areas, seeds may remain dormant for decades, but still germinate under the right conditions. The removal of this layer during development effectively destroys most of the seed bank, contributing to biodiversity loss. In many countries, an integral part of any development involves setting aside the turf and topsoil removed during earth works and then reusing it to reclaim land. For example, in emplacing pipelines, the corridor is stripped of turf and topsoil, the pipeline is trenched, and the turf and topsoil are used to resurface the corridor. After re-establishment, the disturbance is minimised. Not only does this ensure that biodiversity loss is reduced, but it encourages the use of the natural flora in landscaping. In desert areas, where the percentage of plant cover may be low for much of the year, the value of the topsoil may be overlooked, but is nevertheless critical to rapidly re-establish the ephemeral flora.

In order to effectively store and re-use the sandy soils in the UAE, the optimal stripping depth and storage conditions need to be established. It is widely recognised that soils can deteriorate if they are not stored under suitable conditions. For example compaction and consolidation during storage deteriorates soil structure (Hunter and Currie 1956). With increasing depth in soil stores, conditions of the soil change, sometimes rendering the soil anaerobic (Harris et al. 1989). This changes the soil's physical and chemical property and may render it less useful for reclamation procedures. Hence, a classification of top soil types and research into top soil re-use for mitigation of habitat loss should be a high priority, and funding such research would be one means of off-site mitigation.

In projects where the land surface will not be built on or 'greened', such as along pipeline corridors, under pylon lines or areas of levelled or remodelled surface, we suggest that replacement of topsoil for habitat restoration should be a required mitigation strategy.

Wildlife Corridors

Fragmentation of habitats is widely recognised as a major factor leading to biodiversity loss, in terms of habitats, species and genetic diversity. One possible mitigation measure to reduce such fragmentation of species ranges into isolated "islands" is the provision of corridors connecting them (Noss and Harris 1986). Such corridors can either function as valuable linear habitat for smaller species such as reptiles and invertebrates, or as dispersal corridors (Harris and Gallagher 1989) for larger animals. Corridors have at least five functions (Harris and Gallagher 1989): they allow wide-ranging animals to travel, migrate or meet mates; allow pollination and propagation of plants; allow genetic interchange between populations; allow populations to move in response to environmental changes; and allow individuals to re-colonize habitats in which they have become locally extinct.

Creating wildlife corridors in an arid environment is a major challenge due to the harsh climate, low population densities and highly adapted species assemblages. Regardless of the challenge, such corridors are needed to maintain biodiversity and provide suitable habitats for displaced species. For example, recent highway construction and large-scale quarrying activities in the UAE mountains are fragmenting the mountain ecosystem into ever smaller blocks. Provision of corridors linking these areas may allow endangered species such as the caracal lynx (*Felis caracal schmitzi*) and Arabian tahr (*Arabitragus jayakari*) to retain viable populations. As the mountain areas fall into several different emirates, this will require coordinated planning and implementation at the federal level.

Mitigation strategies here are particularly important for projects such as highways and pipelines, which cross the mountain range. Highways in the UAE are usually fenced and lit, and provide impassable obstacles to larger mammals. We recommend that developers be required to build bridged and unfenced wildlife underpasses (which could also function as wadi crossings). Pipelines also should be unfenced and buried, with areas of restored natural surface to allow free movement of animals.

On-site mitigation

On-site mitigation aims to minimise environmental impacts on natural biodiversity within the boundaries of the development site itself. A variety of mitigation strategies are possible, depending on the nature of the site and project.

Preservation of natural habitats

If possible, areas of the site should be set aside as natural habitat and be retained as far as possible in their native state. Even small areas may be sufficient to maintain plants, insects, lizards and small mammals and provide habitat for visiting birds. They may also be extremely valuable as areas for environmental education and recreation. Such areas should be fenced or clearly marked off so that they are not used by contractors as dumping or lay-down areas. Some management of sites may be appropriate, such as provision of signage, information panels, paths or walkways, birding hides, and management of grazing. Such areas can also be designed so that they interlink with other sites providing corridors.

In coastal areas mangroves and shorebird feeding grounds are threatened. They are home to a great variety of biota and are of particular importance for fish, bird and insect species. The shallow sea and intertidal mudflats are important feeding areas for the visiting shorebirds, passage migrants and residents. These should be protected from further damage by minimising future dredging, careful emplacement or removal of dredge spoils, avoidance of dumping construction and other materials onto them and vigilance against pollution.

Preservation of existing indigenous mature trees and shrubs.

Indigenous trees and shrubs are of particular ecological importance in the desert environment as they provide shade and shelter for native wildlife, such as gazelles, and habitat for native invertebrates. They also have an important cultural association and are aesthetically pleasing in the landscape. The factors affecting natural regeneration are poorly known, but overgrazing by goats and camels is likely to be preventing most regeneration. As they take many years to become established, it is important to maintain standing trees wherever possible, designing around them where necessary. In the desert environment ghaf and acacia (*Acacia tortilis* and *A. ehrenbergiana*) are the major trees. The shrub, *Leptadenia pyrotechnica* is a major structural part of the vegetation in some areas, and provides shelter for a variety of animal species such as Arabian hares. In mountainous and gravel plain areas a variety of trees occur, but sidr (*Ziziphus spina-christi*), growing to a large size in the wadi beds, are particularly important.

Sympathetic planting and maintenance

Sympathetic landscape and garden planting, using native species where possible, can make a large difference in the conservation value of a site. Moreover native species tend to have low water requirements, are often salt tolerant and resistant to disease. It is recommended that native trees, shrubs and grasses are used as much as possible in landscaping. For example, ghaf trees are aesthetically pleasing and fast growing, with

low water demands. They are excellent for street planting and screening. Freshwater pools, especially if reed beds are allowed to develop, attract a wide variety of birds and insects. Every effort should be made to avoid the overexploitation and use of freshwater, a valuable resource in a desert country. In the case of greening shoreline developments, problems associated with irrigation, including run-off and eutrophication of the channels and khors, should be avoided by use of salt and heat tolerant species that use minimal quantities of water. Insecticide spraying should be avoided as it affects beneficial insects involved in natural pest control as well the nuisance value insects.

Invasive alien species

Intentional or accidental introduction of alien or non-native species of fauna and flora into areas where they are not normally found can be a significant threat to biodiversity, since some alien species can become invasive, spreading rapidly and out-competing native species. Hence it should be a requirement that developers do not deliberately introduce any alien species with a high risk of invasive behaviour, or any known invasive species, and will exercise diligence to prevent accidental or unintended introductions.

Invasive plant species most likely to affect the many sites in the UAE is mesquite, *Prosopis juliflora* or *P. pallida* (Pasiecznik et al. 2001). These South and Central American species are highly invasive and have already colonized areas of the Emirates (El-Keblawy and Al-Rawai 2007). Extreme care should be used that these species are neither deliberately nor accidentally further introduced into this area. *Prosopis juliflora* is a fast growing, salt-tolerant and drought-tolerant tree that can grow in areas receiving as little as 50 mm of rainfall per year. There is great concern surrounding *Prosopis juliflora*: unmanaged, it often colonizes disturbed, eroded and over-grazed lands, forming dense impenetrable thickets. The dense shade and allelopathic chemicals prevent germination and growth of other plant species. *Prosopis* species have been declared noxious weeds in many countries, including Argentina, Australia, South Africa, Pakistan and Sudan and efforts have been made to control the spread of *P. juliflora* in the UAE and Oman. *Prosopis juliflora* is likely to be in competition with the native *P. cineraria* and *Acacia* species, to the detriment of the range of native organisms they support.

In addition, the pollen from this species is highly allergenic (Killian and McMichael 2004), and UAE studies showed that mesquite was the most common cause of allergic reaction (Bener et al. 2002). It is important that all individuals of this species are removed and that the species is not used in landscaping.

Enclosed animals

Larger animals on a site under development should have provision to leave the site. The site should not be entirely fenced until it is certain that any gazelle have left the area and fences should allow for smaller animals such as hares and foxes to pass through.

Off-site mitigation

A variety of off-site strategies are available, where impacts are mitigated on other property. For example, a developer whose proposed development will result in loss of habitat for endangered or protected species, may be required to fund conservation for the protection of an equivalent amount of similar habitat off the site. Such land may be purchased and donated to a private or governmental organisation to be maintained as a protected area, or funding may be paid as in-lieu fees to protect biodiversity reserves. This is a potentially effective and low-risk strategy, but one that has not yet been adopted in the UAE. If such a strategy is used, it is important to ensure that sufficient funding is provided to maintain the protected site, which may require setting up a suitable endowment. Alternatively developers may be required to provide funding for protecting, restoring or enhancing existing protected areas. Degraded land could be restored and habitats recreated, perhaps using top soil skimmed from the development site.

Another strategy is for developers to be required to fund research into biodiversity issues or ecological management so that future mitigation efforts are more effective. In the UAE, where the level of biological and ecological knowledge of most species and ecosystems remains rudimentary, this strategy could provide valuable insights and significantly contribute to biodiversity conservation practice. In practical terms, this could involve funding recognised experts to conduct focussed projects on particular taxa, funding doctoral and post-doctoral research, development of biodiversity action plans, development of management plans for protected areas, research towards producing data-based Red Lists of species of conservation concern amongst others. Such research should be conducted in partnership with local universities and agencies to help build local conservation capacity. For example, although no insects in the UAE are formally recognised as being endangered, this partly reflects the poor state of knowledge of the insect fauna despite two recent publications, which have added more than 500 new species for the UAE (Howarth and Gillett 2008, van Harten 2008). Insects play a crucial role in the maintenance of the food chains and in pollination of the vegetation. In conjunction with the local authority charged with protection and conservation, developers could undertake sponsorship of environmental awareness and education campaigns involving billboards, posters and leaflets explaining the importance of protecting the unique fauna and flora of the Emirates.

In general, the success of any mitigation strategy put forward as part of the EIA will only be as good as the research it is based on, the willingness of the relevant competent authorities, both local and federal, to implement the law in the allocation of development permits, and the degree of compliance with the mitigation strategies on the part of the developers. At present there is considerable variation among emirates within the process, and in the extent to which the developers and competent authorities are independent bodies. There is a rapidly growing sense of the importance of environmental issues in the country, with the development of a carbon-free city in Abu Dhabi (the Masdar initiative), green building design and modern waste disposal methods. It is

to be hoped that effective ecological mitigation and biodiversity conservation will now become a higher priority in the development of the nation.

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